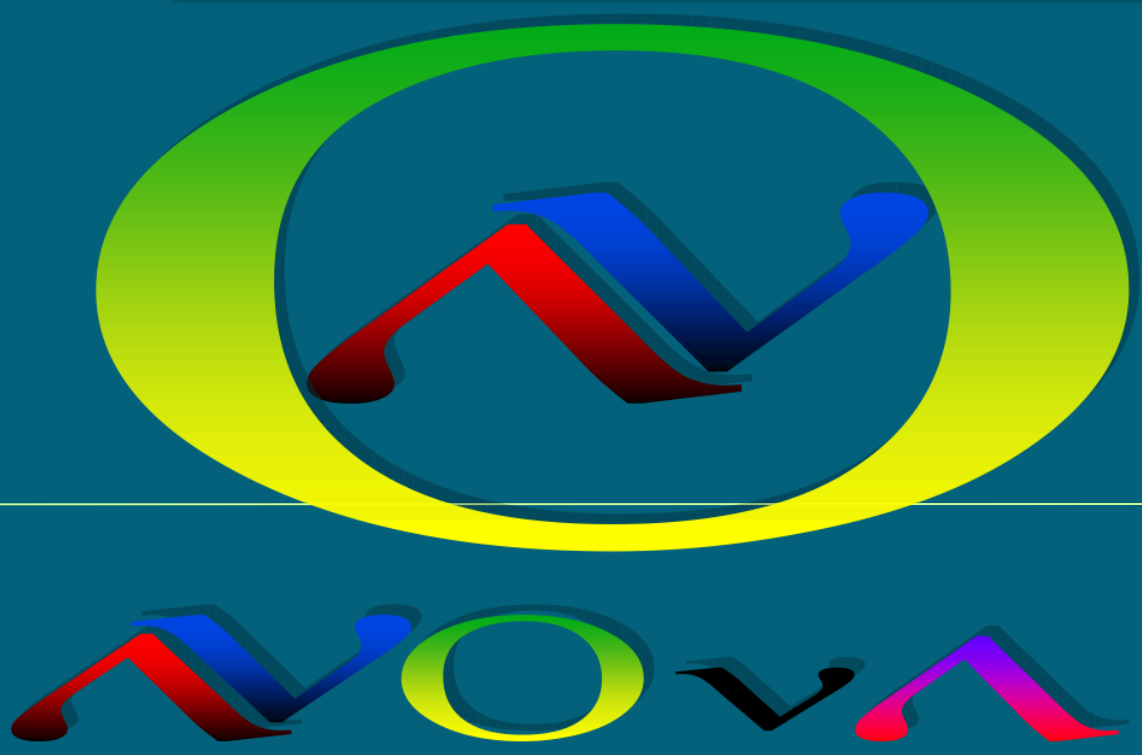


# Early Neutrino Data in the NOvA Near Detector



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On behalf of the NOvA Collaboration

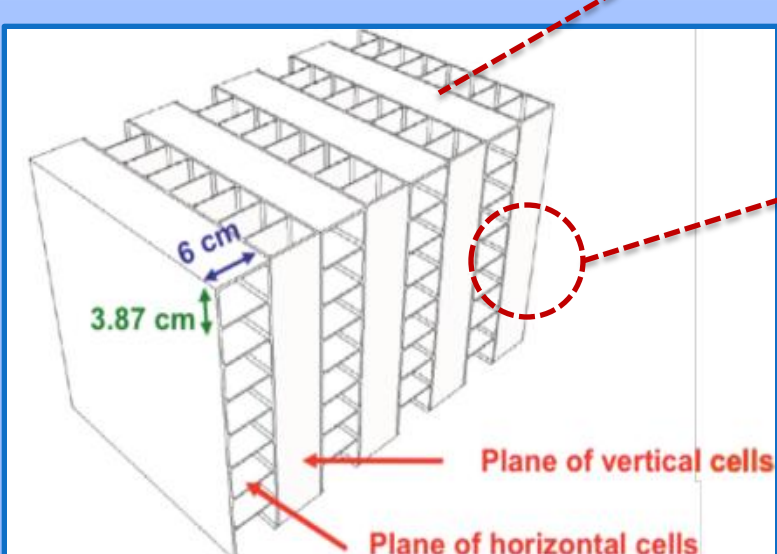
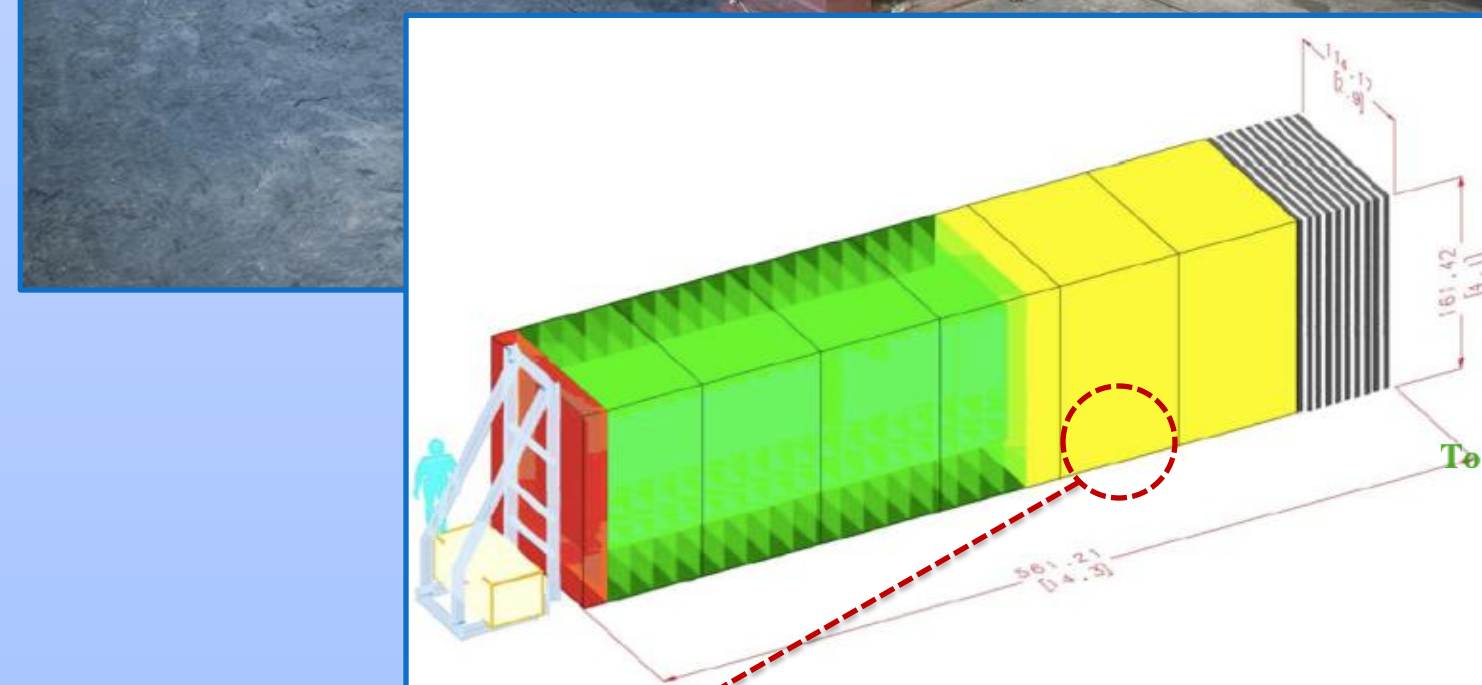
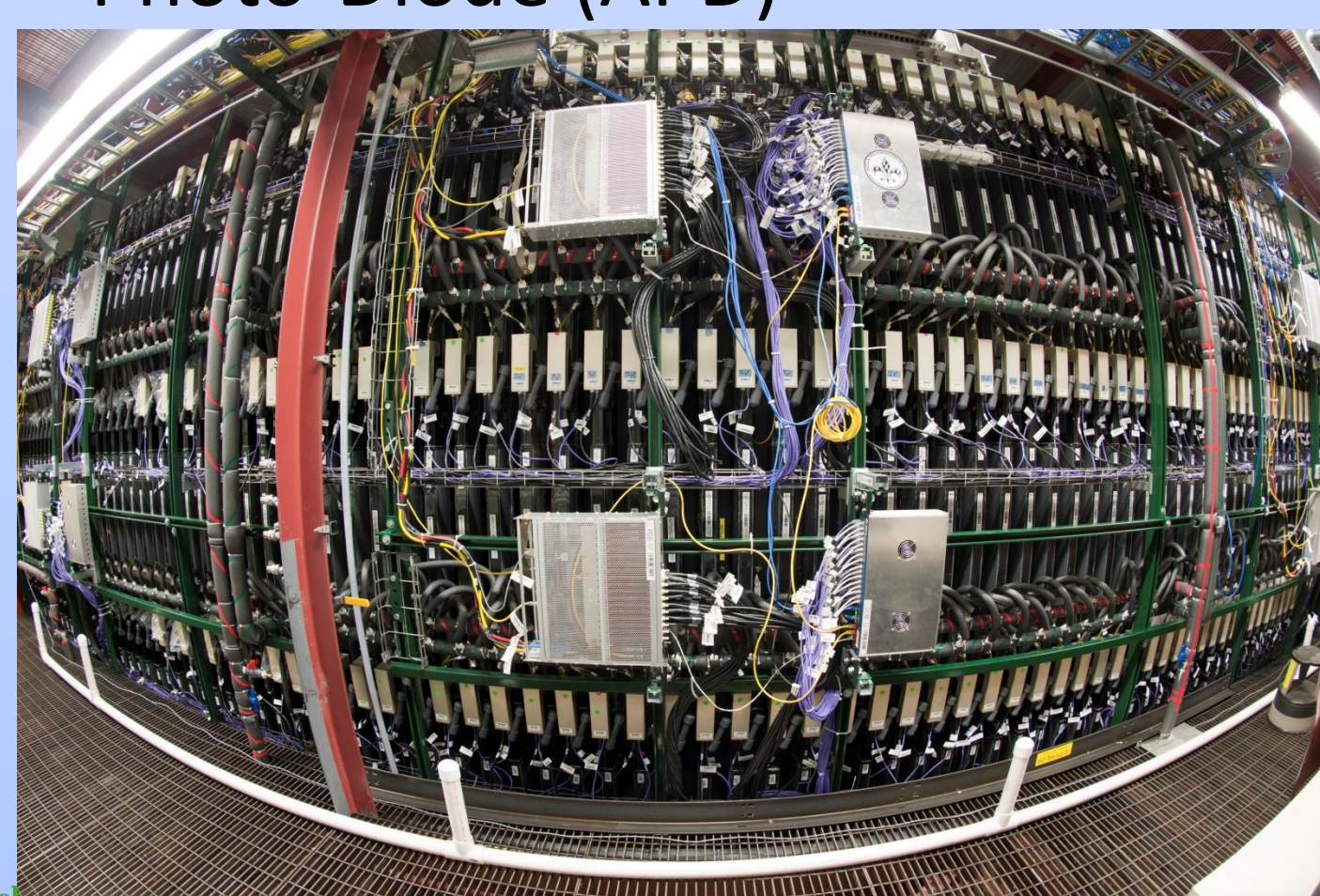


## NOvA Near Detector On the Surface (NDOS)



Detector located on the surface at Fermilab

- Detector made with PVC modules
- Each module is made of 32 cells
- Cells filled with liquid scintillator
- Looped wavelength shifting fiber collects light
- Readout by 32-pixel Avalanche Photo-Diode (APD)



- Prototyping tests:
- Assembly technique
  - Scintillator filling
  - Light yield
  - APD installation and functioning
  - Electronics installation and functioning
  - DAQ functioning

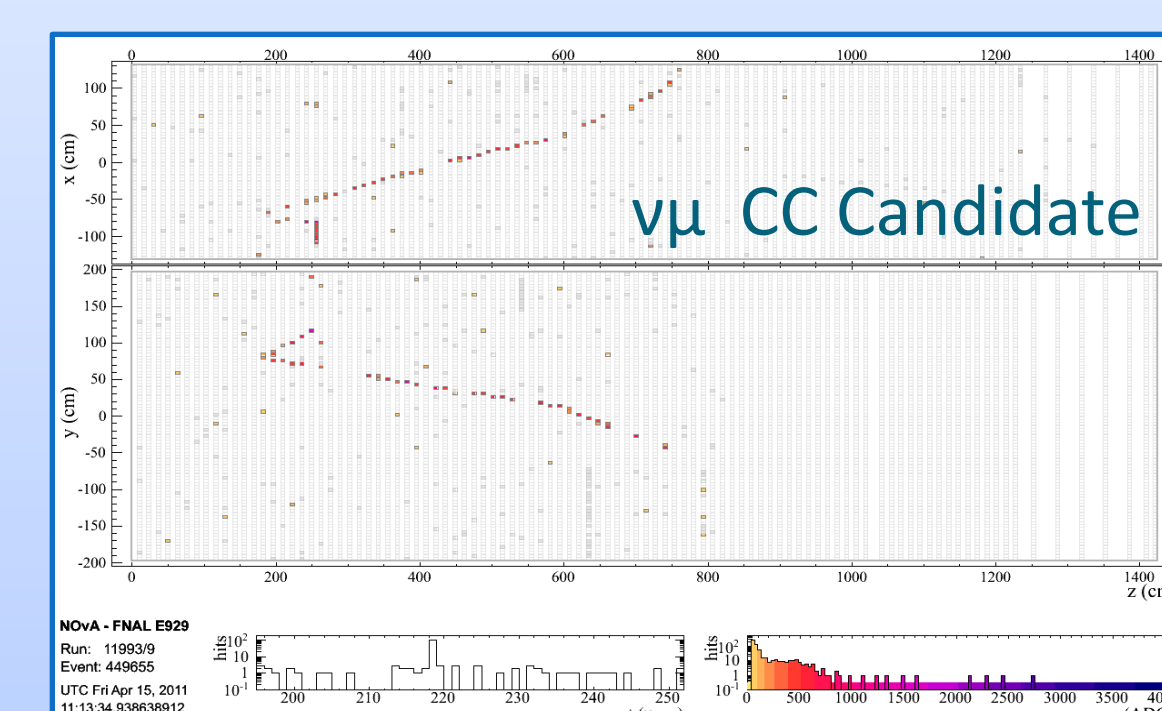
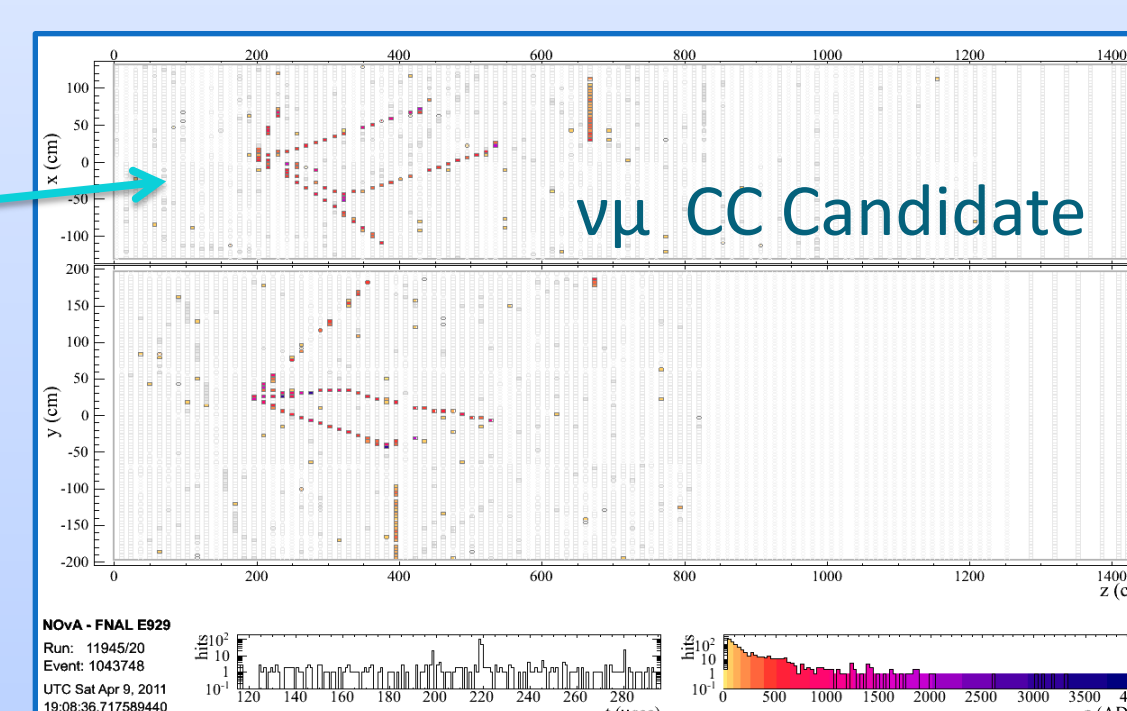
## Physics goals for the Near Detector On the Surface

- Calibrate the detector
- Determine composition of the beam
- Investigate the detector sensitivity to cosmic ray background
- Study response of the detector to electron neutrinos
- Measure the rate of neutrino interactions for quasi-elastic (QE) interactions

## Events in Detector during Commissioning

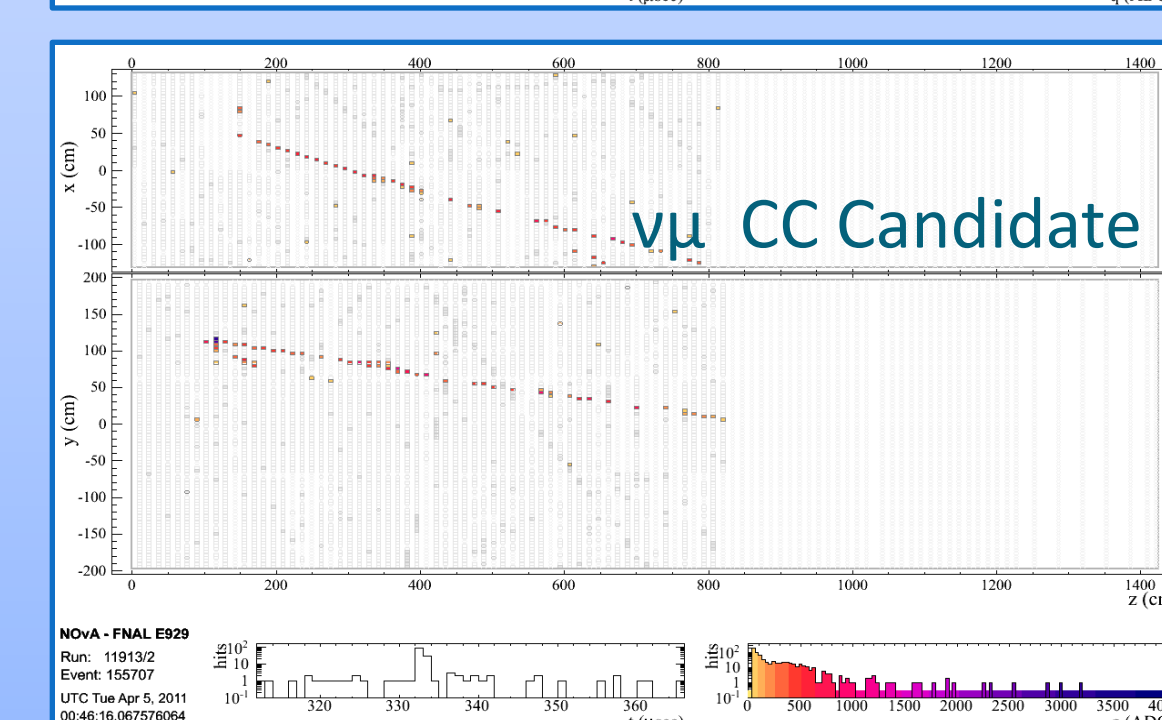
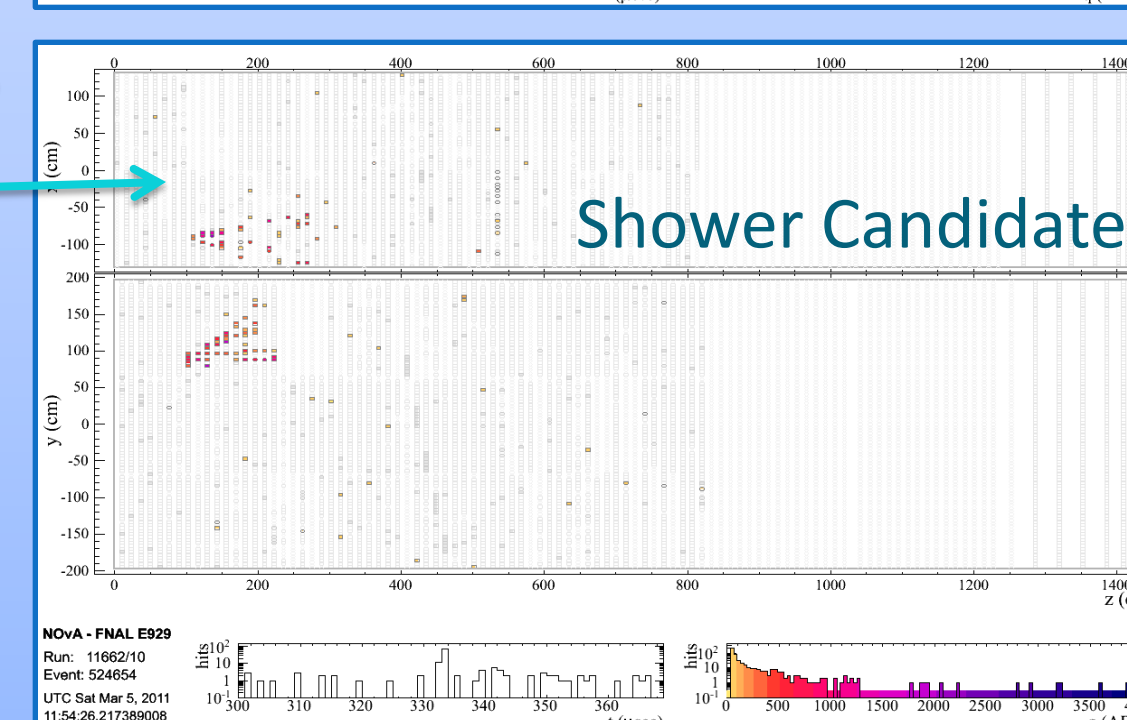
NuMI Events

Beam direction



Booster Events

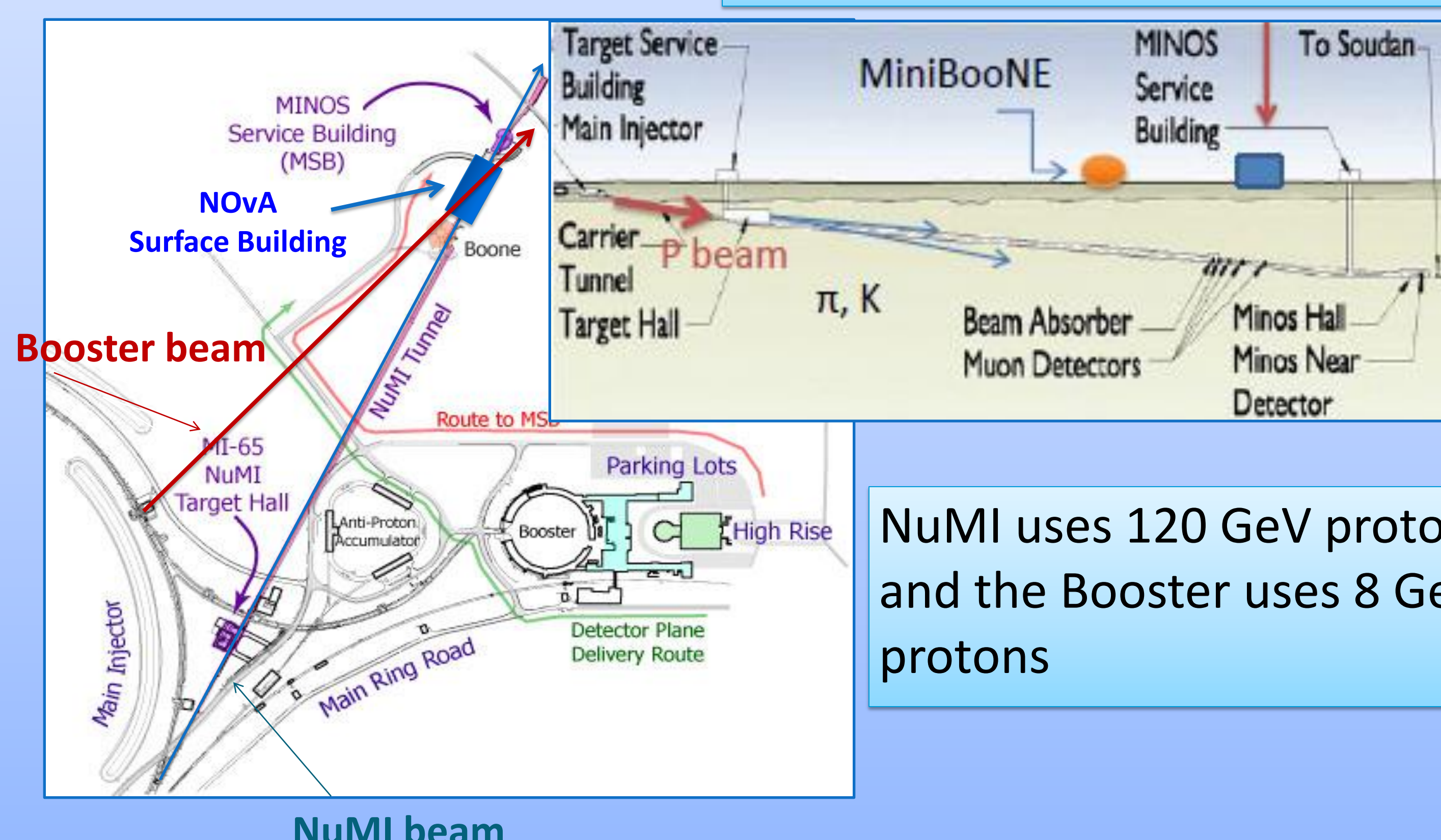
Beam direction



## Near Detector Location

Near Detector taking data from both beams NuMI and Booster

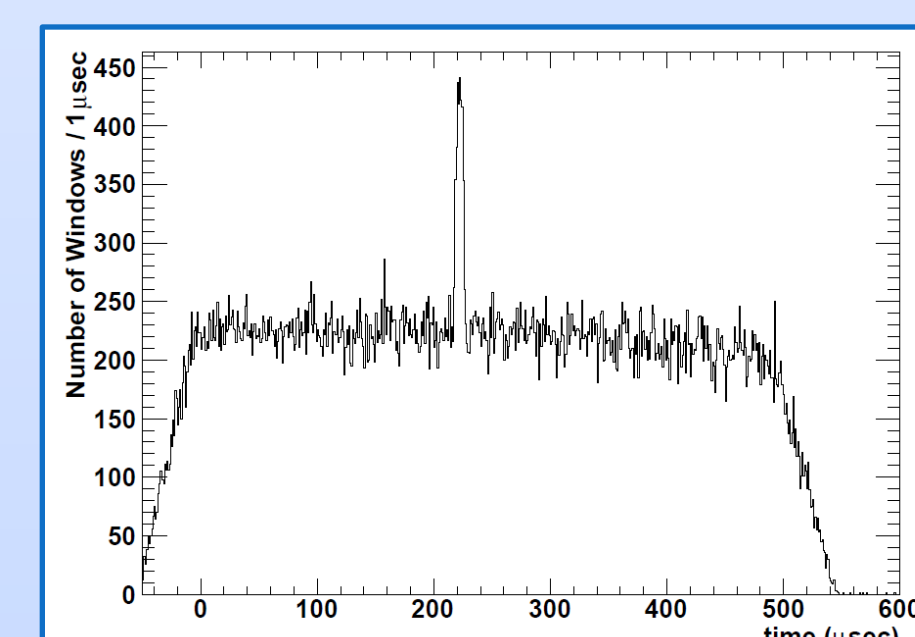
NDOS is  $\sim 6.1^\circ$  off axis of the NuMI beam and on the Booster axis



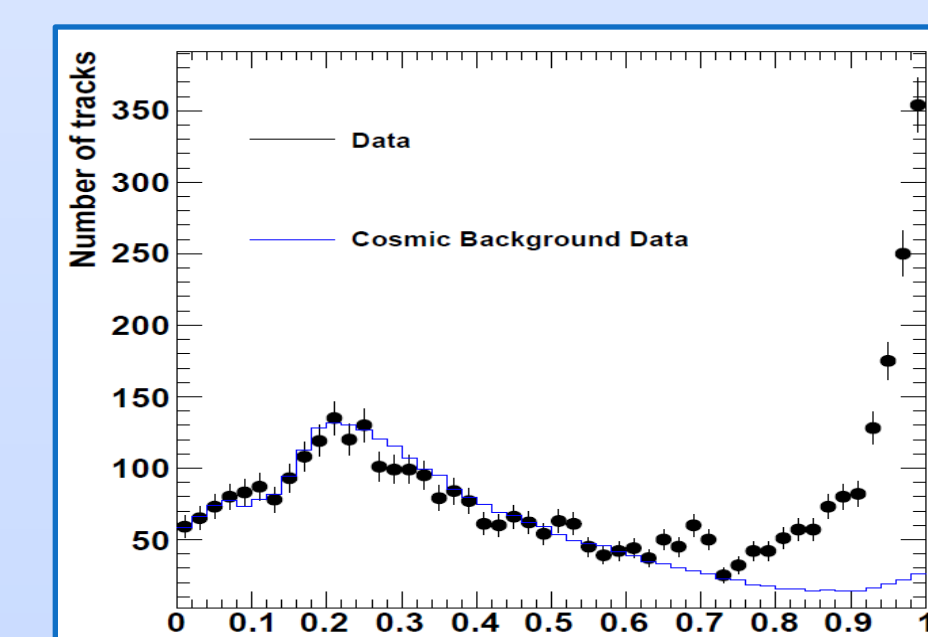
NuMI uses 120 GeV protons and the Booster uses 8 GeV protons

## Neutrino Signal in the Near Detector NuMI Neutrino and Antineutrino mode

Time Distribution

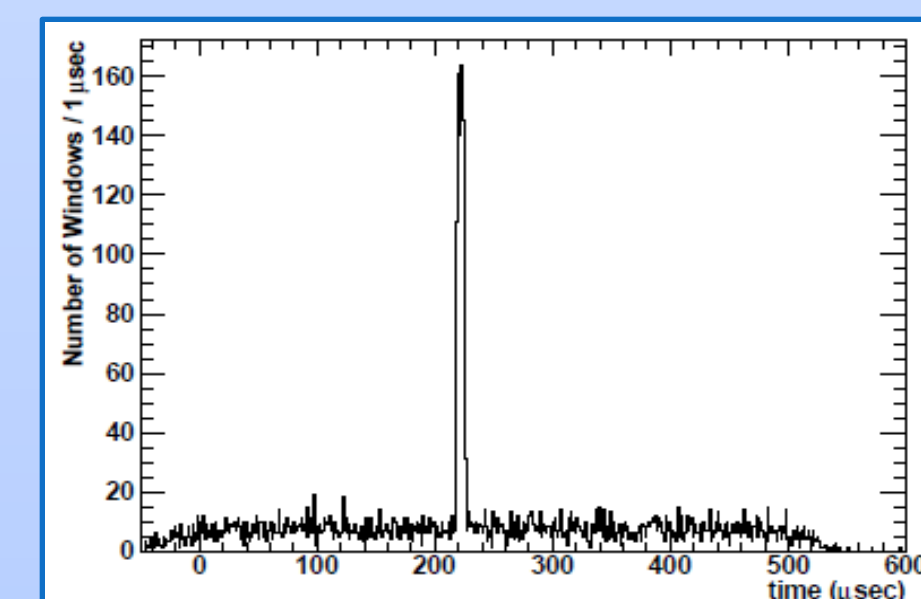


Reconstructed Muon Angle



Requiring activity in the detector and the vertex in the fiducial region

Time Distribution after angle selection



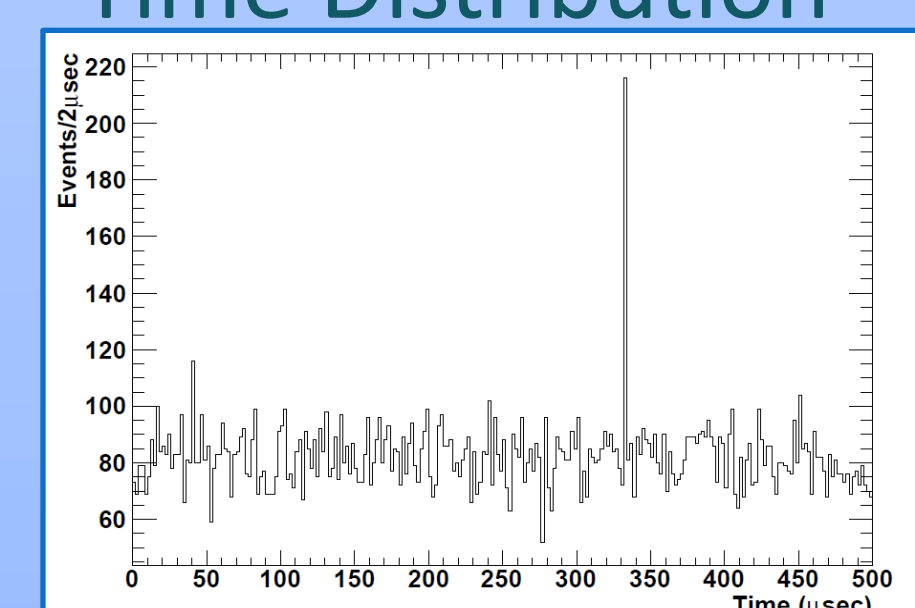
Events Collected

	POT	NuMI	Cosmic Bg
Neutrino	$5.6 \times 10^{18}$	253	39
Antineutrino	$8.4 \times 10^{19}$	1001	69

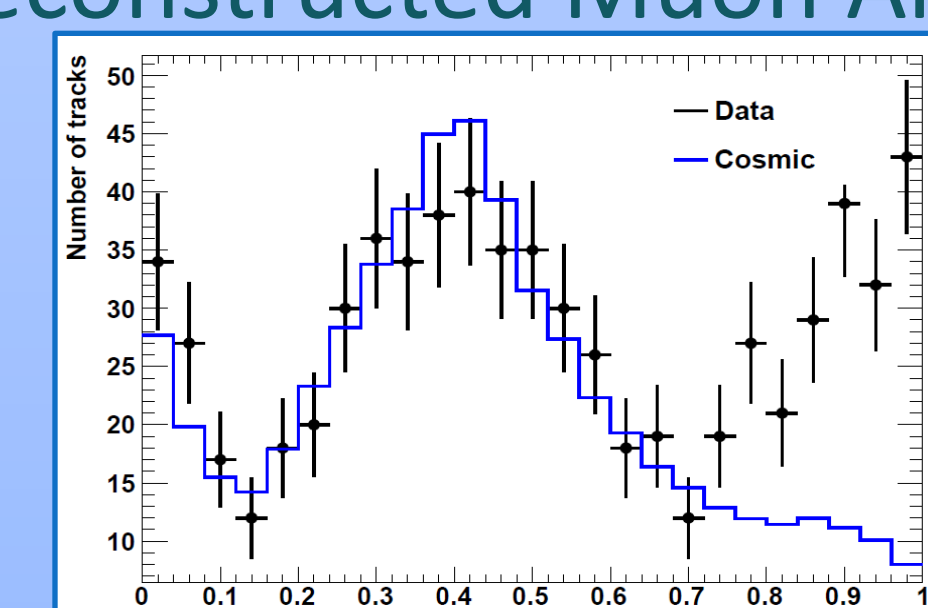
Requiring activity in the detector, vertex in the fiducial region, and consistency with beam direction  $\cos(\theta_{\text{NuMI}}) > 0.85$

## Booster Antineutrino mode

Time Distribution

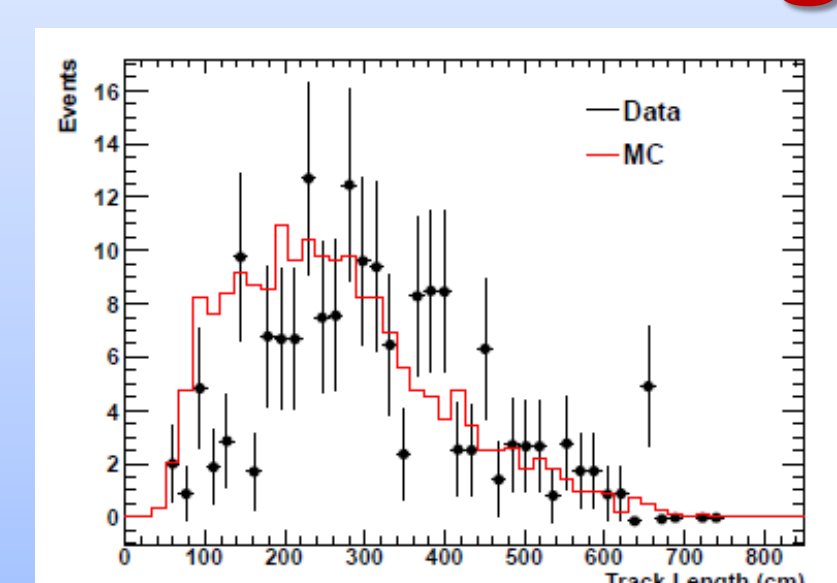


Reconstructed Muon Angle



$3.05 \times 10^{19}$  POT collected from the Booster  
222 Booster events and 92 cosmic background events

## Track Length for NuMI Antineutrinos events



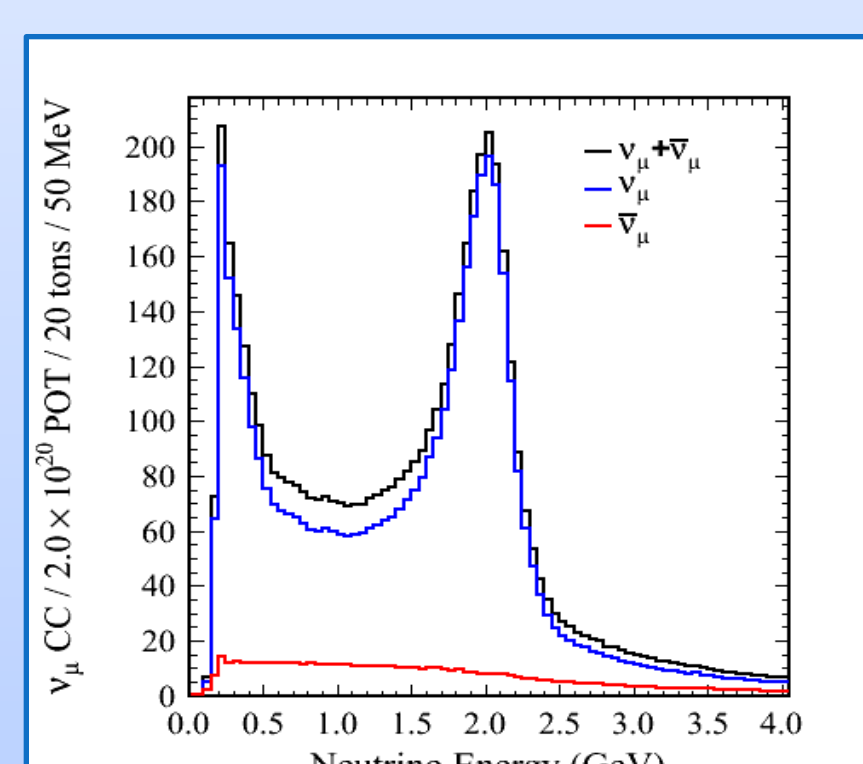
	NuMI	Cosmic Bg	MC
Fiducial	1001	69	861
Fully contained	184	12	187

Fully contained: Events with vertex and end of the track inside of fiducial region

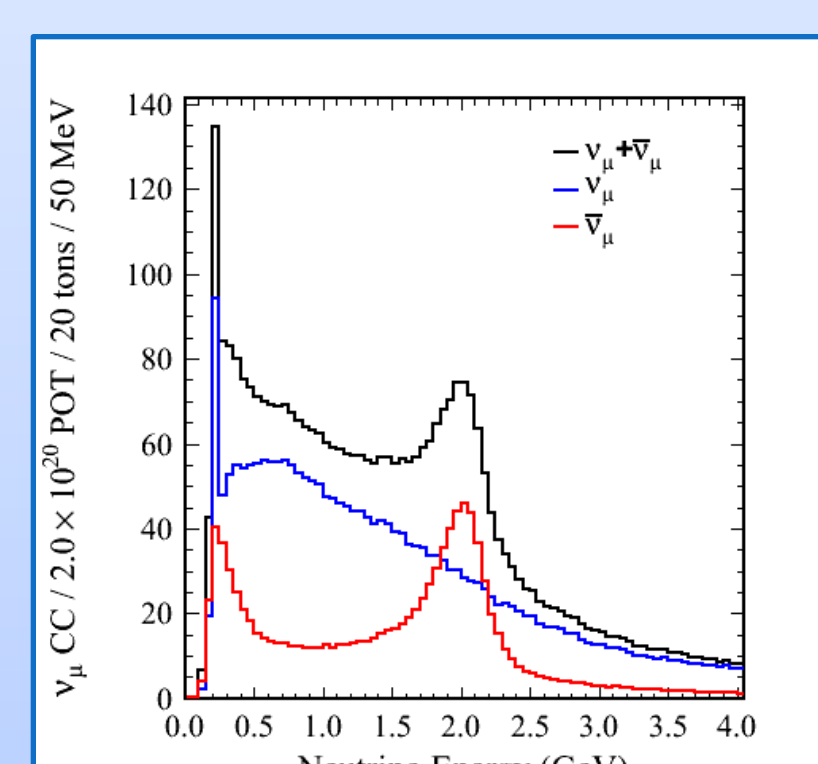
Data-MC track length comparison

## MC Simulations

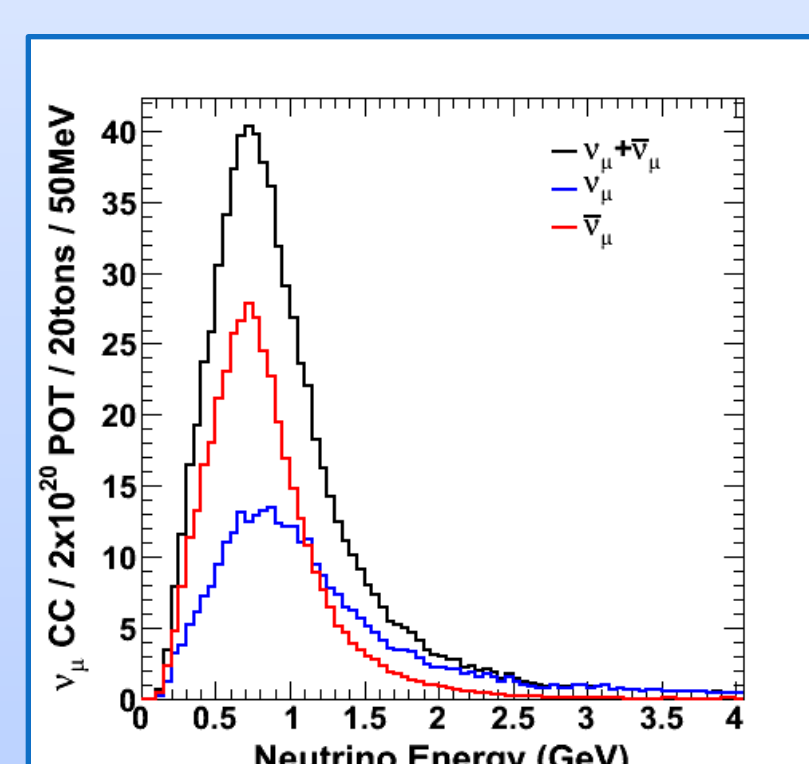
Antineutrino run from NuMI



Antineutrino run from NuMI



Neutrino run from Booster



Expected Event Rates

	$2 \times 10^{20}$ POT (20 tons)	NuMI Neutrino	NuMI Anti-Neutrino	Booster Anti-Neutrino
$\nu_\mu + \text{anti-}\nu_\mu$ CC		4500	3300	735
In 2 GeV peak		1500	800	
$\nu_e + \text{anti-}\nu_e$ CC		200	160	10
NC		2000	1600	392

More details on NOvA see E. Niner and Z. Wang